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Vol. V OCTOBER, 1918 No. 8

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

PAPERS IN THIS NUMBER.

"Notes on the Construction of the Mystic River Bridge of the Boston Elevated Railway." Clarence T. Fernald.

"Mystic River Bridge. Description of Superstructure." John C. Moses.

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Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETING.

BOSTON, MASS., September 18, 1918. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order by the President, Charles M. Spofford, at 8 o'clock.

There were 25 members present.

The record of the May meeting was approved as printed in the June JOURNAL. The Secretary read the record of the June meeting, and it was approved.

The Secretary reported for the Board of Government the election of Mr. Alphonso Bruno to membership in the grade of Member.

The President announced the deaths of the following members of the Society: Mr. Howard L. Coburn, who died June 19, 1918, and Mr. Edward A. Buss, who died August 18, 1918. The President was requested to appoint committees to prepare memoirs.

Prof. George F. Swain, the committee appointed to prepare a memoir of Elmer L. Corthell, presented and read his report. Professor Swain also presented and read a memoir of Franklin B. Locke. Both memoirs were accepted and ordered printed in the JOURNAL.

Mr. Clarence T. Fernald then read a paper entitled, "Notes on the Construction of Mystic River Bridge, Boston." Mr. John C. Moses followed with a description of the construction and erection of the draw span of the Mystic River Bridge.

Both papers were illustrated with lantern slides.

Adjourned.

S. E. TINKHAM, *Secretary.*

ROLL OF HONOR.*

ADDITIONS.

CYR, JOHN P. 301st Engrs., Am. Ex. Force, France.
EICHORN, FREDERICK C. H. 1st Lieutenant, Q. M. C.
FRENCH, CHARLES A. Captain, Q. M. C., Camp Devens, Mass.
JOHNSON, FRANK W. 2d Lieutenant, C. A., U. S. A., Fort Monroe, Va.
PATSTONE, LEWIS F. Major, Engrs., U. S. R., Camp Lee, Va.
PHILLIPS, LAURENCE J. Co. C, 212th Field Signal B'n, Camp Devens, Mass.
SHERMAN, EDWARD C. Lieutenant-Commander, U. S. N. R. F., Bureau of Yards and Docks, Washington, D. C.

REVISIONS.

† REED, LESLIE P. 1st Lieutenant, U. S. Signal Reserve Corps, Engr. Section.
ROBINSON, ASHLEY Q. Musician, 334th Field Artillery Band, Headquarters Co., 87th Div., Am. Ex. Force, France.
ST. AMAND, LOUIS J. Private, 6th Co., 152d D. B., Camp Upton, N. Y.
SAWYER, GEORGE S. Sergeant, Co. A, 504th Engr. B'n, Am. Ex. Force, France.

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* Members who are in the service and have not yet reported that fact to the Secretary are earnestly requested to do so, stating branch of service, rank and military address.

† Died in service.

LIST OF MEMBERS.

CHANGES IN ADDRESS.

Bonnet, Frederic, Jr.	Care U. S. Ammonium Nitrate Plant, Perryville, Md.
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Raymond, John W., Jr.	51 Lovett St., Beverly, Mass.
Smith, Sidney	Hotel Browning, Grand Rapids, Mich.
Tinkham, Charles S.	47 Riddell St., Greenfield, Mass.

DEATHS.

Reed, Leslie P.	September 26, 1918.
Stevens, George M.	September 19, 1918.

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society rooms two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

424. Age 40. Received technical education at Mass. Inst. of Technology. Has had wide experience along civil engineering lines, including water-supply engineering for Metropolitan Water and Sewerage Board, inspection and reports for National Board of Fire Underwriters on water-supply systems and fire apparatus, building location and construction for Quartermaster Dept., U. S. A., in Philippine Islands, and housing development for U. S. Shipping Board. Salary desired, $200 to $250 per month, depending on location and conditions.

LIBRARY NOTES.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports.

Advice to Forest Planters in Plains Region. Seward D. Smith.

Annual Report of Interstate Commerce Commission on Statistics of Express Companies in United States for 1917 and 1916.

Bibliography of Petroleum and Allied Substances, 1915. E. H. Burroughs.

Cotton Production in United States, Crop of 1917.

Design of Public Roads. Charles H. Moorefield.

Diffusion of Oxygen through Stored Coal. S. H. Katz.

Effects of Moisture on Spontaneous Heating of Stored Coal. S. H. Katz and H. C. Porter.

Lumber Used in Manufacture of Wooden Products. J. C. Nellis.

Mining and Concentration of Carnotite Ores. Karl L. Kithil and John A. Davis.

Miscellaneous Conifers of Rocky Mountain Region. George B. Sudworth.

Notes on Geology and Iron Ores of Cuyuna District, Minnesota. E. C. Harder and A. W. Johnston.

Notes on Greensand Deposits of Eastern United States. George H. Ashley.

Occupational Hazards at Blast-Furnace Plants and Accident Prevention. Frederick H. Willcox.

Phosphate Rock in 1916. Ralph W. Stone.

Typical Specifications for Non-Bituminous Road Materials. Prévost Hubbard and Frank H. Jackson, Jr.

United States Tariff Commission: Outline of Its Work and Plans, 1917.

Utilization of Elm. W. D. Brush.

Zirconium and Rare-Earth Minerals in 1916. Waldemar T. Schaller.

State Reports.

Michigan. Engineering Bulletins of State Board of Health as follows: Public Water Supplies and Sewer Systems of Michigan, by Edward D. Rich; Sewage Disposal, by Edward D. Rich and F. Gardner Legg.

City and Town Reports.

Boston, Mass. Annual Report of Finance Commission for 1917–18.

Chicago, Ill. Excess Condemnation: Why City of Chicago Should Have Power, in Making Public Improvements, to Take Property in Excess of Actual Requirements. Bureau of Public Efficiency.

Holyoke, Mass. Annual Report of Board of Water Commissioners for 1917.

Somerville, Mass. Annual Report of Water Commissioner for 1917.

Miscellaneous.

(The) Engineering Profession Fifty Years Hence. J. A. L. Waddell. Gift of author.

Hydrated Lime Bureau: Concrete Evidence; Hydrated Lime in Concrete.

Lime Association: Hydrated Lime in Concrete Roads.

(The) Motor Truck Problem. Textile Department, Merchants National Bank.

National Safety Council: Teaching of Safety in Technical Schools and Universities, 1918.

Naval Consulting Board: The Enemy Submarine.

Ports and Terminal Facilities. Roy S. MacElwee.

Vulcanite Portland Cement Co.: Organic Impurities in Sand.

Library Committee.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

NOTES ON THE CONSTRUCTION OF THE MYSTIC RIVER BRIDGE, EVERETT EXTENSION OF THE BOSTON ELEVATED RAILWAY COMPANY.

By Clarence T. Fernald,* Member Boston Society of Civil Engineers.

(Presented September 18, 1918.)

History.—The inception of the Everett Extension, so-called, began with the acceptance of Chapter 497 of the Acts of the Legislature for 1907, by the cities of Everett and Malden, and the Boston Elevated Railway Company, in July, 1907.

Not until four additional acts had been passed by the legislatures of 1913, 1915 and 1916, was construction started, and yet again in 1917 still another act was passed relative to the location of a permanent station in Everett.

The intervening time between these dates, or a total of about nine years, was occupied by the Company in making surveys, studies, or holding conferences and trying to satisfy or reconcile the various factions in these two cities as to route, type of construction, location of stations, and obtaining the necessary approvals of governmental boards.

The greatest modification in legislation, however, was made by the passage of Chapter 777 of the Acts of the Legislature for 1913, by which the location for an elevated railway in Everett and Malden north of the Broadway crossing over the Boston &

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*Assistant Engineer, Boston Elevated Railway Company, 101 Milk St., Boston, Mass.

Note.—Discussion of this paper is invited, to be received by W. L. Butcher, Editor, before December 10, 1918, for publication in a subsequent issue of the Journal.

Maine Railroad was revoked, and a route for a double-track subway substantially following the line of Main Street was substituted in its place.

It was under this new act that work on the plans for the present bridge began.

The original bridge plans which had received the approval of all the local boards, needing only the sanction of the Secretary of War, and having been contracted for contingent upon the approval of all the public authorities, were abandoned.

By reason of this new act of 1913 the Company found itself with numerous parcels of real estate on its hands, in many instances having razed the old buildings to proceed with the new construction.

Its obligations relative to the Mystic River Bridge, however, were the most onerous, as they involved the following items:

a. The relocation of the channel 334 ft. further north.

b. The construction of a new highway drawbridge.

c. The rebuilding of the pile bridge approaches, and an approach 900 ft. long on filled land.

The type of foundations, length of spans, type of steel structure and details of the drawbridge for the new elevated bridge were entirely changed, and all the approvals had to be again obtained before construction could begin.

The foregoing facts are cited as a concrete instance of the difficulties encountered by public service corporations, who are obliged to proceed in good faith in their contracts with municipalities. These municipalities act on the theory that the power which gives may take away, and as views change with every administration so do the laws regardless of previous obligations. In my humble opinion, some safeguard should be provided to make contracts of this kind as inviolate as are those between commercial houses or corporations, during the term of the contract, i.e., adequate compensation being guaranteed for any change from the original contract.

General Layout of Work.

The plans as finally approved by the several boards (Fig. 1) provided for a bridge or elevated steel structure crossing the

Mystic River from a point on the south shore about 80 ft. west of the highway bridge, and joining the north end of the Beacham Street car yard, to a point near the pumping station of the Metropolitan Sewerage System, a distance of 844 ft ±. From this point the Elevated structure continues for about 2 341 ft., where it reaches the ground and the tracks extending on the surface to the proposed temporary station, a total distance of one mile north of the present Sullivan Square Terminal.

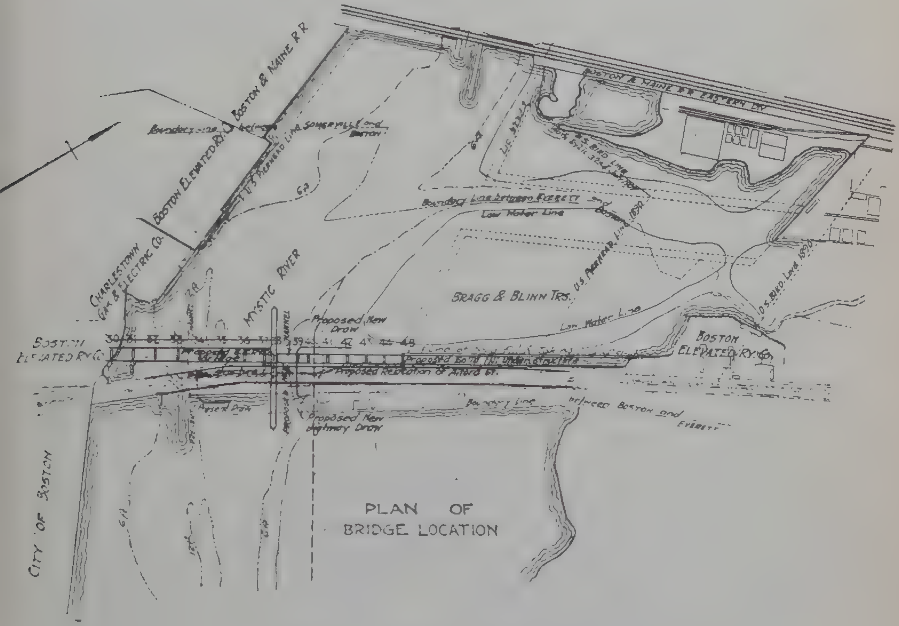

FIG. 1. PLAN OF BRIDGE LOCATION.

The alignment of the highway bridge was moved westerly about one half its width, to a line parallel to and about 18 ft. away from the Elevated structure. North of the pile bridge the approach included the construction of a heavy sea wall, 300 ft. long, averaging 16 ft. high, and a 4-ft. to 5-ft. fill extending 600 ft. further north.

In each bridge there was located a Strauss bascule drawbridge, providing for a width of 75 ft. clear opening, and a depth of 30 ft. of water.

The railway drawbridge was built at a high level, having from 26 ft. to 28 ft. headroom under it at high water, the counterweights being underhung. The highway drawbridge had a moving leaf, 60 ft. wide and 105 ft. long, and was of the heel trunnion type, i. e., the counterweight was suspended over the roadway, being supported upon upright columns hinged at the rear or heel end of the moving leaf. Both drawbridges were built by the Boston Bridge Works.

BRIDGE FOUNDATIONS.

The depth of water at the draw opening was fixed by the War Department at 30 ft., and here the dredging for the channel foundations on either side was carried down to about elevation 68, and the piles were cut at 69.50 in piers 39 and 39E; those in pier 38 were not cut but left at about elevation 71, the plane of reference being 100 ft. below Boston base.

The piles for all the other piers, excepting the two abutments, were cut at grade 80, and the abutments at grade 85.

DESIGN.

The piers for the three-track structure were 44.75 ft. by 17.25 ft., and for the two-track structure north of the draw 34.17 ft. by 16.66 ft. bottom dimensions, the former having 102 piles and the latter 78 piles, averaging 30 ft. long and spaced 2.5 ft. on centers. (See Plates I and II.)

The four large draw piers (see Plates III and IV), viz., Nos. 37, 38, 39 and 39E, varied in size from 124 ft. by 19 ft. to 34.17 ft. by 19.16 ft., and the latter three were carried down to about grade 69.5, as previously noted.

In all cases the concrete, of 1 : 2 : 4 mixture, was carried from the piles to grade 99. Above this point the work was of quarry-faced granite backed with 1 : 2½ : 5 concrete; the coping stone was finished with 4-cut work on top, having quarry-faced edges with 2 in. draft line at top and bottom, the finished work being at grade 117.

PLATE I.
JOURNAL BOSTON SOCIETY
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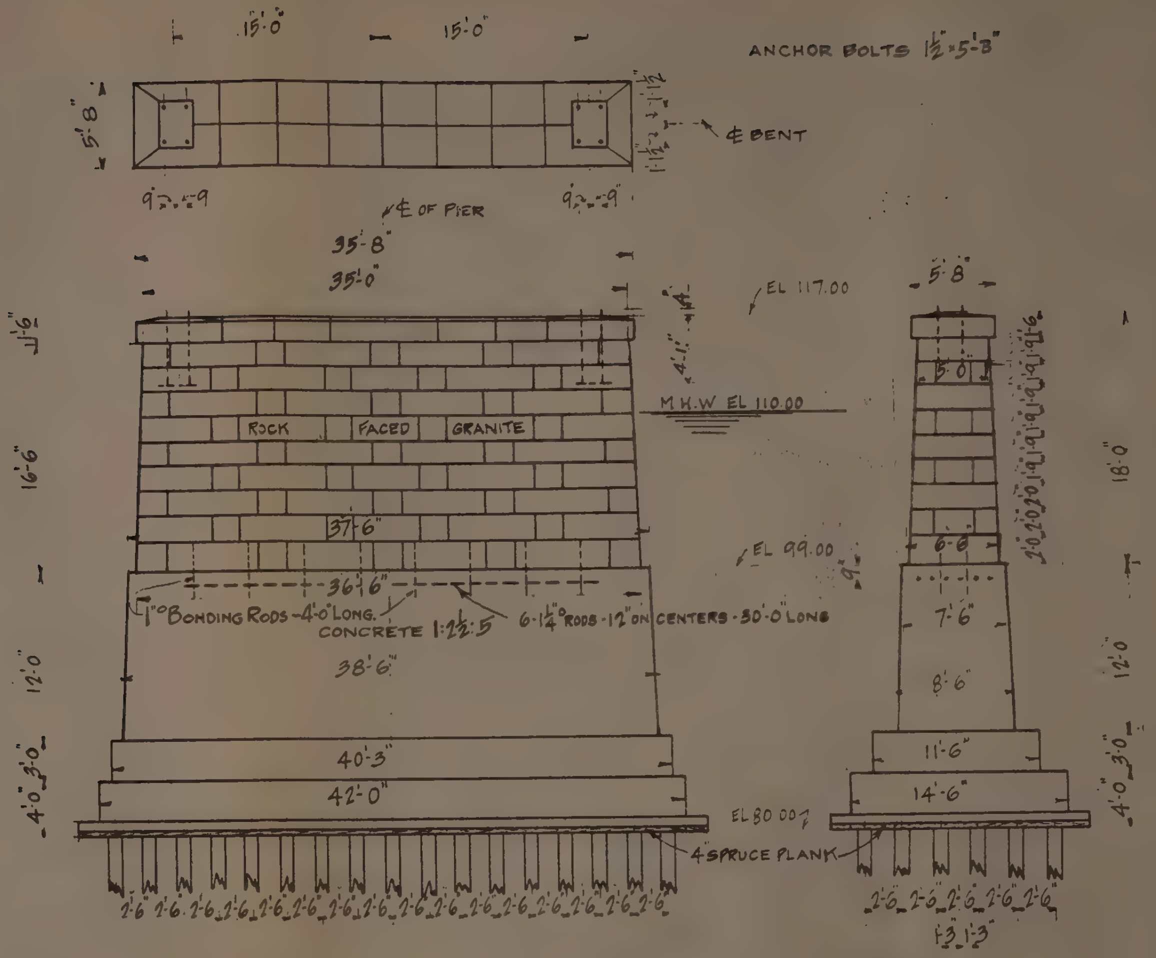
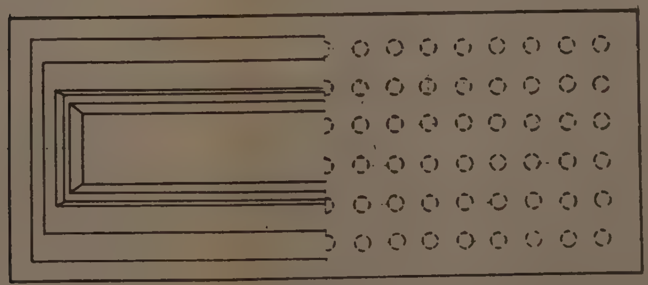
OCTOBER, 1918.
FERNALD ON
MYSTIC RIVER BRIDGE.

DETAILS OF
PIERS 30 TO 36, INC.



— SIDE ELEVATION —
102 PILES

— END ELEVATION —



— HALF PLAN AT EL 115.50 — HALF PLAN AT EL. 81.00 —

The four large piers at the draw were of special design, to meet the conditions imposed by their necessary depth, distribution of load, and methods of construction. The maximum load calculated for the piles was about 14 tons, assumed to occur when the bridges were open and subjected to a wind force of 15 miles per hour.

The minimum spacing for piles was 2.5 ft. on centers, and of course at points of heaviest loading.

Construction.

On March 20, 1916, a contract for the work was let to the Hugh Nawn Contracting Company.

The conditions controlling the construction of these bridges, and imposed by the necessity of keeping traffic moving over the old bridge as nearly normal as possible during its reconstruction, made the operations interesting at all times, and difficult at many others.

This traffic was to be maintained on one half of the old bridge, while the depth of the channel piers endangered not only its safety by undermining the piles, but its northerly abutment as well.

In addition to this, there was a 54-in. gas tunnel built through sand about 42 ft. down stream from the deep piers, and 11 ft. above their bottom.

On the northerly approach to the bridge the dredging necessary for the piers and sea wall caused a movement of the fill in the old street which at times gave considerable anxiety.

The first step taken, therefore, on the construction was to reinforce the floor of the down-stream half of the old bridge and draw, and relocate the outbound surface car track along this side of the old bridge.

Borings taken along the site of the new bridge indicated a bottom of soft or medium blue clay, overlaid with silt and gray sand varying from fine to quite coarse, and in depths of from 4 ft. to 20 ft. The bottoms of all the piers penetrated to this clay formation.

Dredging was begun on the northerly end of the bridge site, from near the north abutment of the old bridge to the abutment of the new bridge. The soft material of sand and silt encountered here gave considerable trouble until the pier caissons were actually landed, as it was constantly pushing in from the street side.

METHOD OF CONSTRUCTING PIERS.

The box-caisson method of construction was called for by the contract, in all cases except the channel piers, where four suggested methods were mentioned, viz., by box caisson, open concrete caisson, steel sheet piling cofferdam, which was to be finally removed, and by spliced steel sheet piling, the lower section to remain in place. The contractor built one of the channel piers (No. 38) by the latter method and the remaining channel piers (Nos. 39 and 39E), by the box-caisson method.

This method of construction proved to be very satisfactory and efficient. It was carried on by the contractor in the following manner.

The site of the pier was first dredged to a depth of about 3 ft. below the cut-off of the piles, which were then driven, and cut to grade by a circular saw mounted on the pile-driver gins. Guide piles were then driven around the site of the pier, the caissons floated in place, gradually sinking to position as the concrete forms inside them were filled.

CAISSONS.

The bottoms of the caissons were really concrete scows, the bottom dimensons being of the exact sizes of the pier footings and were 4 ft. in height, being divided into compartments about 9 ft. wide by cross partitions. Around the bottom there projected a lip or flange having eye bolts cast into it, to which the wooden sides were attached by hook bolts extending for the full height of the sides, and were tightened by set nuts seating on the top sills. (Fig. 2.)

The concrete caissons were built on ways, and launched at the north end of the bridge. The floor was of 3-in. spruce planks greased and laid on the ways in such a manner that by sawing through six planks the caisson was launched. The planks were thickly studded with 20*d*. nails to hold the concrete floor and sides which were cast directly in the forms.

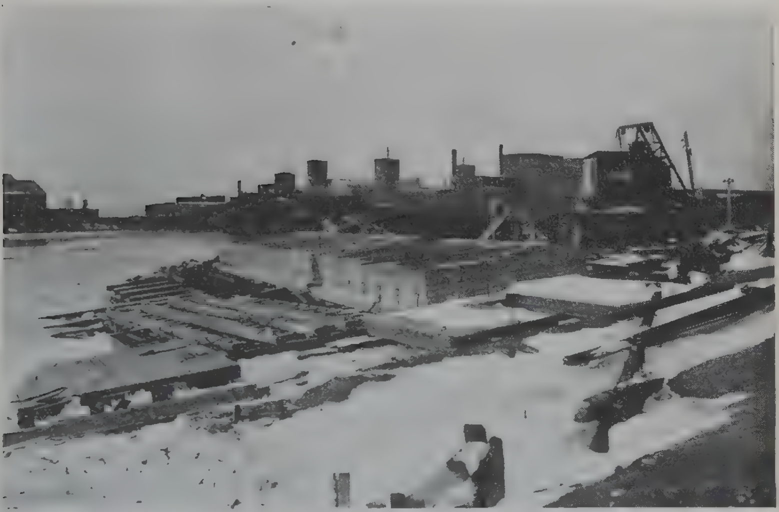


FIG. 2. MYSTIC RIVER VIADUCT. CONCRETE BASE OF CAISSON ON WAYS.

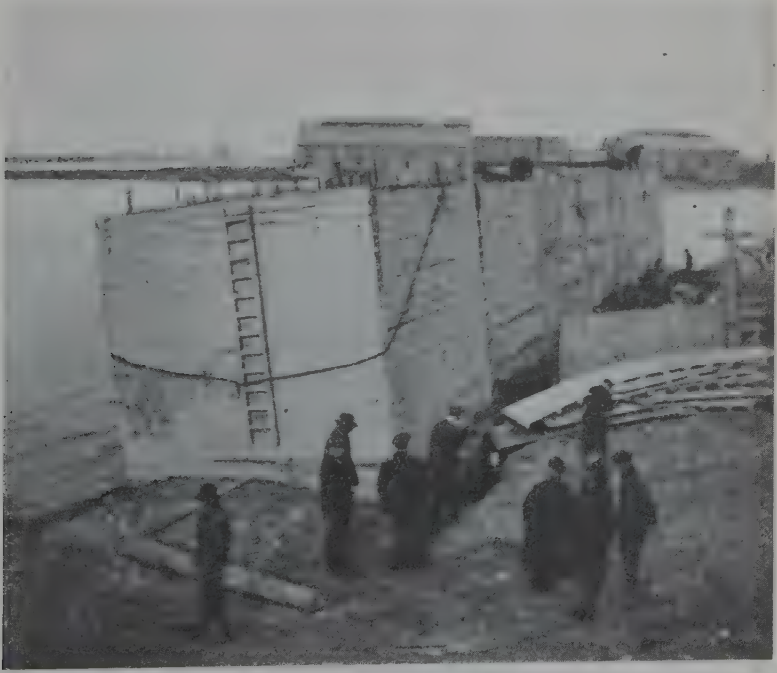


FIG. 3. MYSTIC RIVER VIADUCT. CAISSON FOR PIER 37 READY FOR LAUNCHING.

The caissons were thoroughly reinforced, the sides and flange being 12 ins., the bottom 6 ins., and partitions 9 ins. thick, made of 1 : 2 : 4 concrete.

Wooden sides were made in two sections, the bottom one being 16 ft. and the top one 17 ft. in height. The frame was of 10-in. by 10-in. and 10-in. by 12-in. hard pine, the bottom set was sheathed with 3-in. spruce planed, and the top set was sheathed with 2-in. spruce planed. The edges of the plank were beveled to provide for calking with oakum. These sides were used from three to four times each, and on account of their substantial and careful construction gave no trouble whatever; in most cases a single 3-in. duplex pump would handle all the leakage, in many instances under 14 ft. to 15 ft. head, by pumping a few moments at a time. (Figs. 3, 4 and 5.)

The advantages of this method were, economy of material, work all done in the dry, speed of operation and accuracy as to grade and alignment. The largest caisson sunk, which was 124.6 ft. long and 19.5 ft. wide, was successfully launched with lower sides in place, floated and sunk in place without trouble.

For pier 38, a cofferdam of 14 in. arched (35 lb.) Lackawanna steel sheet piling was used. This was spliced at grades 77 and 79 alternately for the tops of lower planks. Previous to driving this sheeting the area of the new channel piers and channel above and below the old bridge was dredged to grade 80. The up-stream half of the old bridge had been removed, and a bulkhead of oak piles with spur shores up stream had been driven to prevent a movement of the river bottom over the gas tunnel. Then the down-stream end of the steel cofferdam was driven close against the remaining half of the old bridge. After this the dredging was completed to grade 68 ±, the piles driven, and the tops were left at grade 71 ±.

In driving the 30-ft. piles for this pier and pier No. 37, it was found that they would go their full length with from four to five blows.

The pile driver used was a heavy Vulcan No. 1 steam hammer, weighing about 8 500 lbs., and, with the extension gins attached, made a total weight of between $5\frac{1}{2}$ and 6 tons. Longer piles were decided upon, and new ones from 40 ft. to 45 ft. were

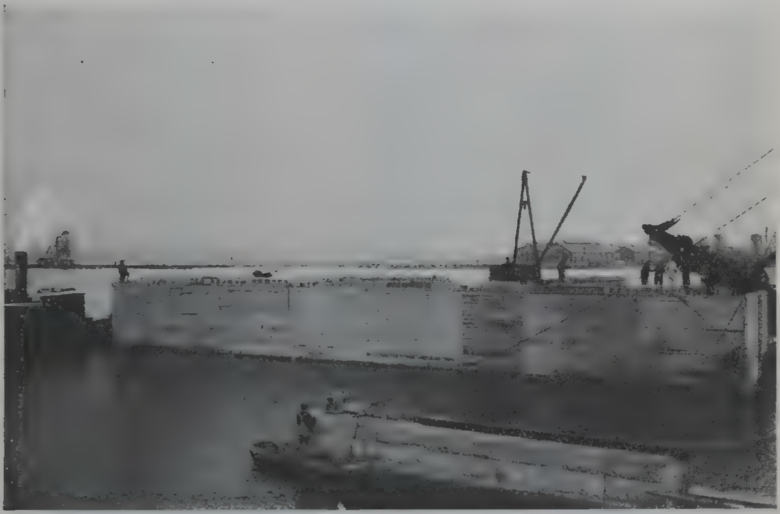


Fig. 4. Mystic River Viaduct. Floating Caisson.

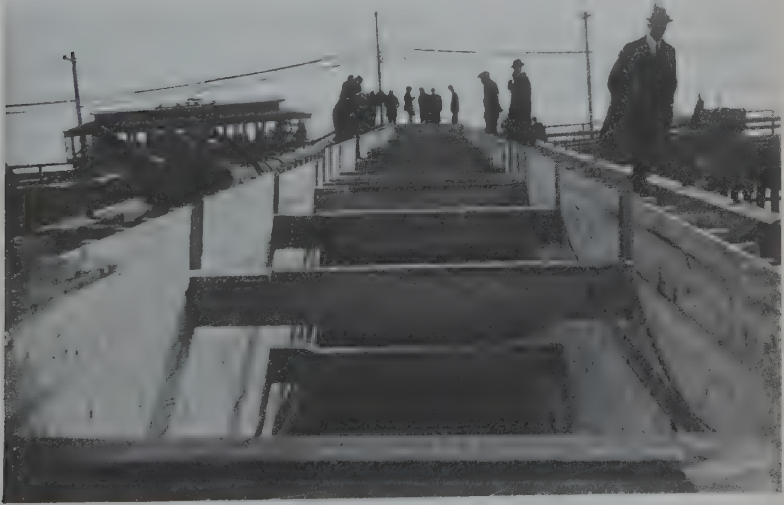


Fig. 5. Mystic River Viaduct. Top of Caisson.

driven. A test was made on one of each length of piles, the following morning, and it required eleven blows on the 30 ft. and thirteen blows on the 40-ft. pile to set them down one foot.

The steel cofferdam was then completed, after which concrete was deposited under water inside of it to grade 76 by means of bottom dumping buckets.

The cofferdam was then unwatered, and the balance of the work done in the dry.

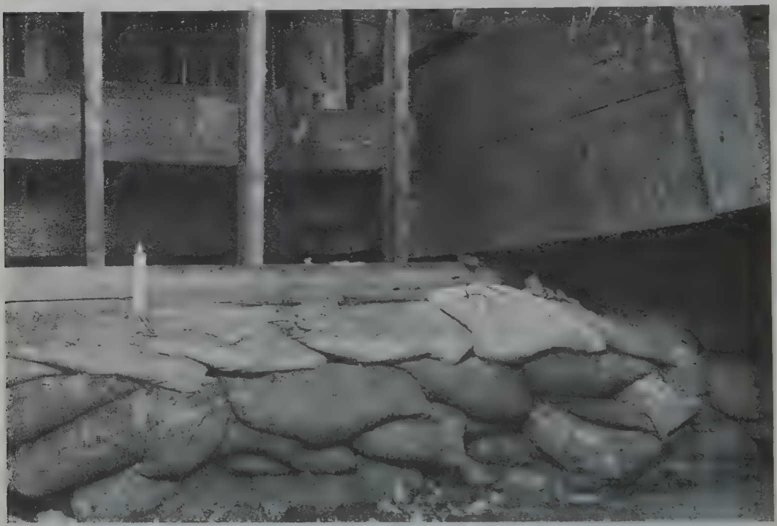


Fig. 6. Top of Concrete Pier 38 at Grade 76 ±.

Considerable difficulty was experienced in unwatering the cofferdam, due to lack of large pumps, at one time there being eight pumps at work, varying in size from 6 ins. to 15 ins. The 15-in. pump finally got the jump or initial head which tightened the pressure on the piling, and eventually succeeded in emptying the cofferdam. When once this was accomplished a single 6-in. pump took care of the leakage.

The top of concrete deposited under water was cleared, and the new work was carried on by building pockets of concrete mixed 1 : 2 : 4, placed dry in onion sacks. (Fig. 6.) These

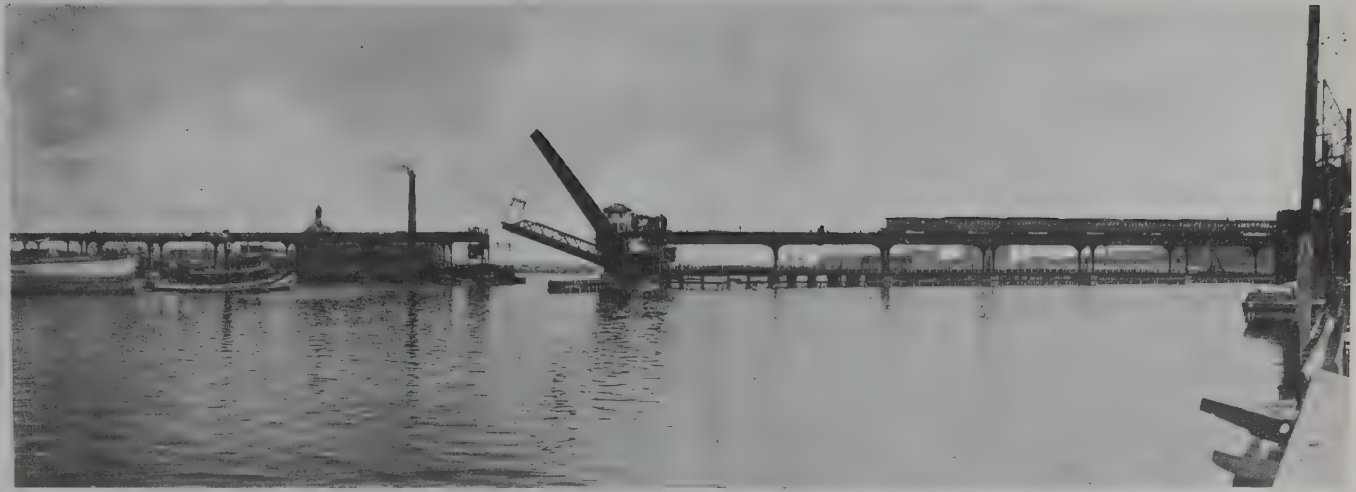


Fig. 7. General View of Bridge and Viaduct.

pockets were about 20 ft. long, 2 ft. high, conforming on the outside edge to the lines of the foundation; the dam of bags left a space of 2 ft. between it and the steel sheeting for drainage, and provided a dry interior for placing the new concrete. At times this work was carried on under 34-ft. head of water outside the cofferdam.

There was nothing of peculiar interest in the stone masonry work. The seats for all posts and bearings were left $\frac{1}{2}$-in. high, to be dressed in the field to exact grade. This proved to be a wise precaution in several instances, as the coping stones were cut rather full. Fig. 7 shows the completed structure.

The construction work was carried on by the Hugh Nawn Contracting Company, having Mr. Kimball Garland, now first lieutenant in the 101st Regiment of Engineers (old First Corps Cadets) as designing engineer for caissons sides and caisson reinforcing.

The bridge was designed by Mr. Robert B. Davis, structural engineer of the Boston Elevated Railway Company, assisted by Mr. L. S. Cowles. Mr. Frederic H. Fay was consulting engineer.

The supervision of construction was in charge of the writer, assisted by Mr. William L. Blanchard, resident engineer, on the railroad bridge work, and Mr. John H. Coghlan on the highway bridge; and to the faithful and painstaking work of these two latter-named men the successful completion of the work owes no small share.

Vol. V OCTOBER, 1918 No. 8

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

MYSTIC RIVER BRIDGE. DESCRIPTION OF SUPERSTRUCTURE.

BY JOHN C. MOSES,* MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

(Presented September 18, 1918.)

THE steel superstructure of the bridge over the Mystic River near Sullivan Square consists of four parts, — the highway draw, the railway draw, the operator's house and the railway viaduct. Both draw spans are of the Strauss bascule type.

The highway draw is designed to carry 50-ton electric cars and heavy city traffic. It consists of two pony trusses 12 ft. deep, with plate girder floor beams and steel stringers. The trusses are 102 ft. long from the center of the trunnions to the end bearing, and are 43 ft. apart, the sidewalks being carried on 8-ft. brackets outside of the trusses. The roadway floor has a wearing surface of 4-in. wide kreolited maple and beech planks, set on edge and laid at right angles to the roadway. They are supported by 4 in. by 8 in. hard pine longitudinal stringers laid 16 ins. on centers, and these in turn are carried by 6 in. by 8 in. hard pine cross ties spaced 2 ft. on centers and bolted to the longitudinal steel stringers at each bearing point. The sidewalks are of 2-in. plank, nailed to 4 in. by 6 in. spiking pieces that are bolted to the tops of the steel stringers.

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*Engineer of Construction for the Boston Bridge Works, Inc.

NOTE. — Discussion of this paper is invited, to be received by W. L. Butcher, Editor, before December 10, 1918, for publication in a subsequent issue of the JOURNAL.

One end of the span is carried by trunnions. These are steel shafts 16 ins. in diameter and 5 ft. long, that rest in bronze-lined boxes. The boxes are supported by triangular trusses that distribute the load to two piers 30 ft. apart. These piers extend up stream to carry the operator's house and the railway span. The main trusses extend 15 ft. beyond the trunnions and carry at these points a counterweight of 750 tons. This weight is a block of reinforced concrete 30 ft. by 20 ft. by 45 ft. in size, and supported by two posts that rest on pins in the trusses. These pins are in a straight line with the trunnion and the center of gravity of the entire span. The upper ends of the posts are connected by a link to posts that rest on top of the trunnions. This link, being parallel to the line from the trunnion to the counterweight pin, holds the weight always vertical, and the bridge is therefore in balance in all positions if balanced in any one position. The trunnions carry the live load as well as the dead load, the total amount being about 1 200 tons, and the pressure on the bearings about 2 000 lbs. per square inch. The counterweight contains pockets for varying its weight if found necessary at any future time.

The highway span is operated by a train of gears driven by two 35-h.p. motors, the last pinions of the train driving circular racks that are bolted to the trusses with the trunnions as their centers. (Fig. 1.) The rack teeth are 4½-in. pitch by 10-in. face. All gearing and boxes are of steel. Motor-driven latches on the forward ends of the trusses hold the span fast when closed, and a 12-in. dashpot is provided, to lessen the jar when closing. A bumping post is built into the pier, to limit the opening movement.

The highway draw was erected in the closed position by a movable stiff-leg derrick with a boom of twenty tons capacity. Pile bents were driven to receive the truss as it was placed by the traveler. The same traveler erected the house between the two draw spans. A stationary stiff-leg derrick unloaded the material from the motor trucks that brought it to the site, and placed it on cars that carried it on a service track to the traveler.

The highway span contains about 300 tons of steel, 30 tons of machinery, and 50 000 ft. of lumber.

The railway draw consists of two deck plate girder spans, 120 ft. long, placed side by side and capable of being operated as one unit or separately. The forward ends of the spans are carried by the cross girder of the adjacent viaduct. The trunnions are carried by eight posts that also support the girders that carry the track of the viaduct on that side of the channel. The counterweights for this span are hung below the floor level. They are of very irregular shape, to clear the posts, girders, piers and other limiting features, and are heavily loaded with iron punchings to secure the necessary weight. There are two weights, each containing about 45 yds. of concrete. The front and rear portions of these weights are differently proportioned in order to obtain a weight per cubic foot of 170 lbs. and 202 lbs. respectively. An approximate balance about the point of suspension is obtained by this means, and links are provided in addition, to keep the weights in a vertical position during the movement of the bridge. The weights are also provided with pockets, for future adjustment if it is found necessary.

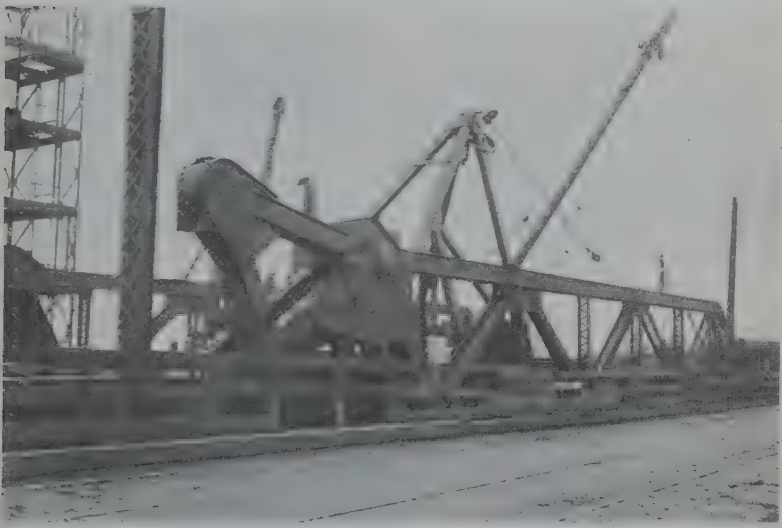

FIG. 1. HEEL END OF HIGHWAY DRAWBRIDGE, SHOWING COUNTERWEIGHT PIN AND RACK.

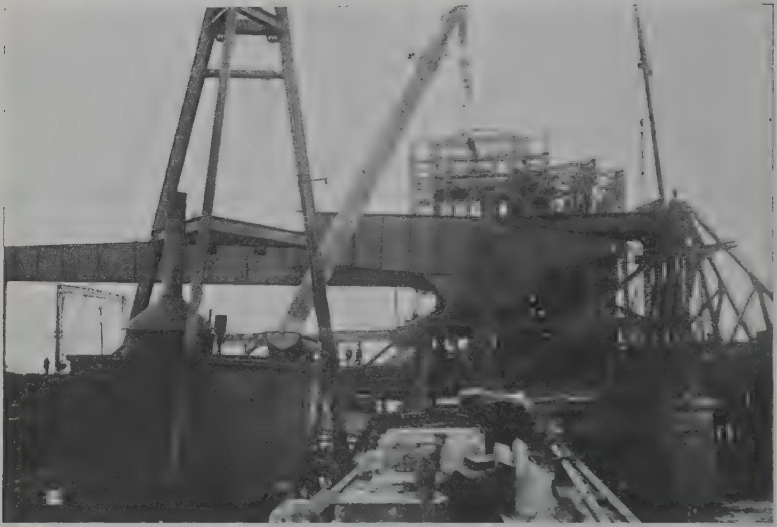

FIG. 2. ERECTING SEGMENTAL SECTION OF RAILWAY DRAW SPAN.

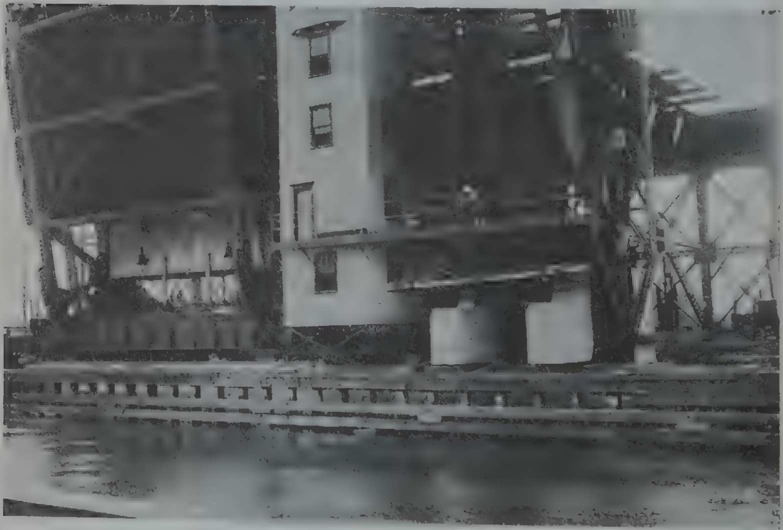

FIG. 3. UNDERSIDE OF DRAWBRIDGES, SHOWING POSITION OF COUNTERWEIGHTS.

The railway draw is operated by two 25-h.p. motors that drive racks bolted to the girders. It is locked in its closed position by motor-driven plungers that are supported by the adjacent viaduct and are supplied with current from the operator's house through a submarine cable.

The girders for this span were shipped from the shop in halves and were erected by a lighter that placed the trunnion halves first. (Fig. 2.) When these had been secured in place, the lighter placed the other halves with their outer ends supported by the viaduct, no falsework being required.

The railway draw contains about 160 tons of steel and 15 tons of machinery. A standard floor of ties with guard rails, track and third rails, walks, railings, etc., was laid by the forces of the Boston Elevated Railway.

The operator's house is between the two draw spans. It is a steel-frame building 13 ft. by 40 ft. in plan, and five stories in height, and contains about 25 tons of steel. The walls and floors are of concrete. The operator's room is the top floor. It contains two switchboards and the controllers, brake levers, signals, etc. The entire wire system for operating, lighting, signaling and protecting each bridge is kept separate from the other. Automatic cutout devices, interlocking mechanisms, lamp signals and other safeguards are provided to aid the operators and to prevent injury to the machinery from careless handling. The motors for the highway draw are under the sidewalks of the approach span, and are in metal houses that also cover most of the gearing and the mechanical brakes. The motors for the railway draw are in the second story of the house. All exposed gearing is protected by gear covers; and foot walks, stairways and ladders are provided for access to all parts. Fig. 3 shows the underside of the drawbridges, and Figs. 4 and 5 show the completed structure in operation.

The railway viaduct (Fig. 6) is about 1 700 ft. long, having 32 spans and weighing about 1 200 tons. It consists of four lines of plate girders supported by transverse girders that are supported in turn by two posts each. The details conform to the standards of the Boston Elevated Railway. The viaduct was erected by a lighter.

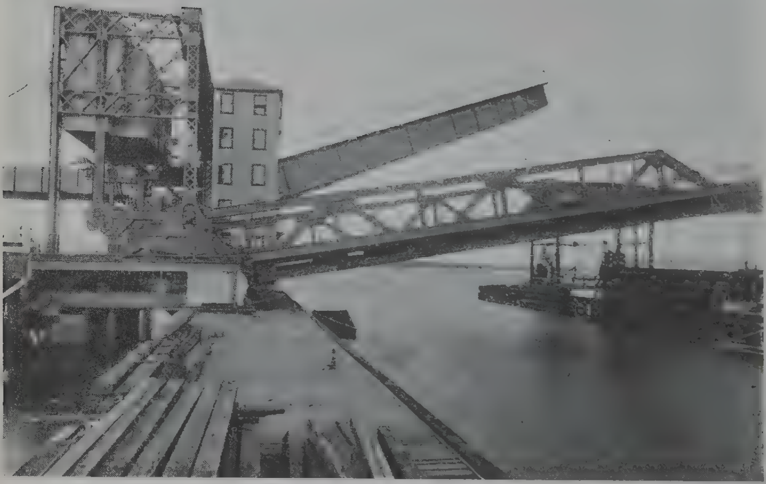

FIG. 4. COMPLETED STRUCTURE IN OPERATION.

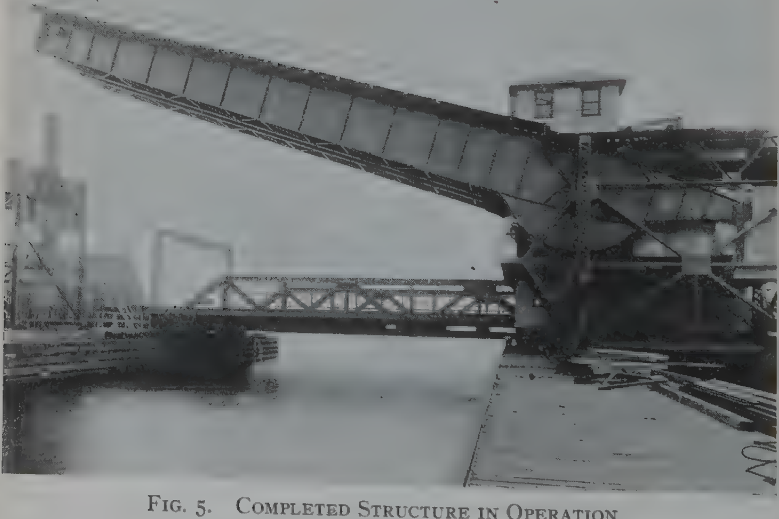

FIG. 5. COMPLETED STRUCTURE IN OPERATION.

The general contract for the superstructure was taken by the McClintic-Marshall Company, who sublet all but the viaduct to the Boston Bridge Works. General Electric Company motors were used. The Jennison-Wright Company furnished the kreolited planking, and the Hugh Nawn Contracting Company built the concrete counterweights. All the work was inspected in the shop and field by the Gulick-Henderson Company.

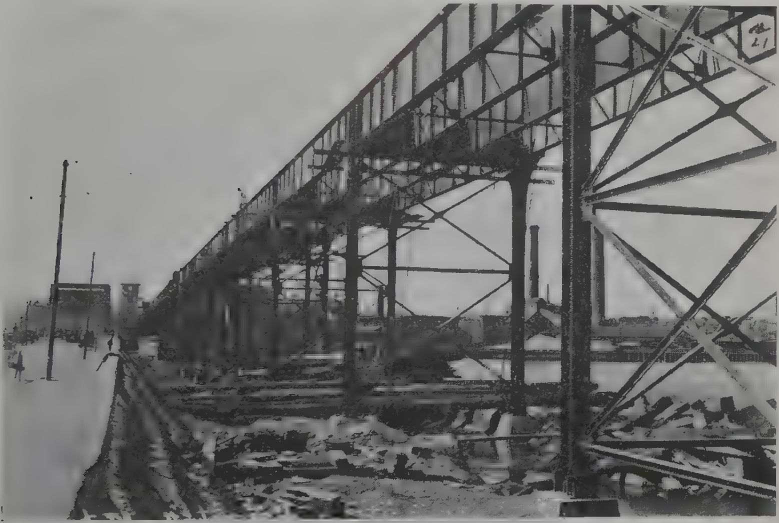

FIG. 6. GENERAL VIEW OF VIADUCT.

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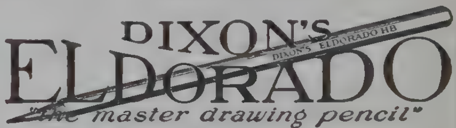

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